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Thermoplastic matrix systems for large marine structures

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Thermoplastic matrix systems for large marine structures

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Part of the INTERREG 2Seas program which is part financed by the European Regional Development fund

GOALS



Drive for innovation
in new composite
materials

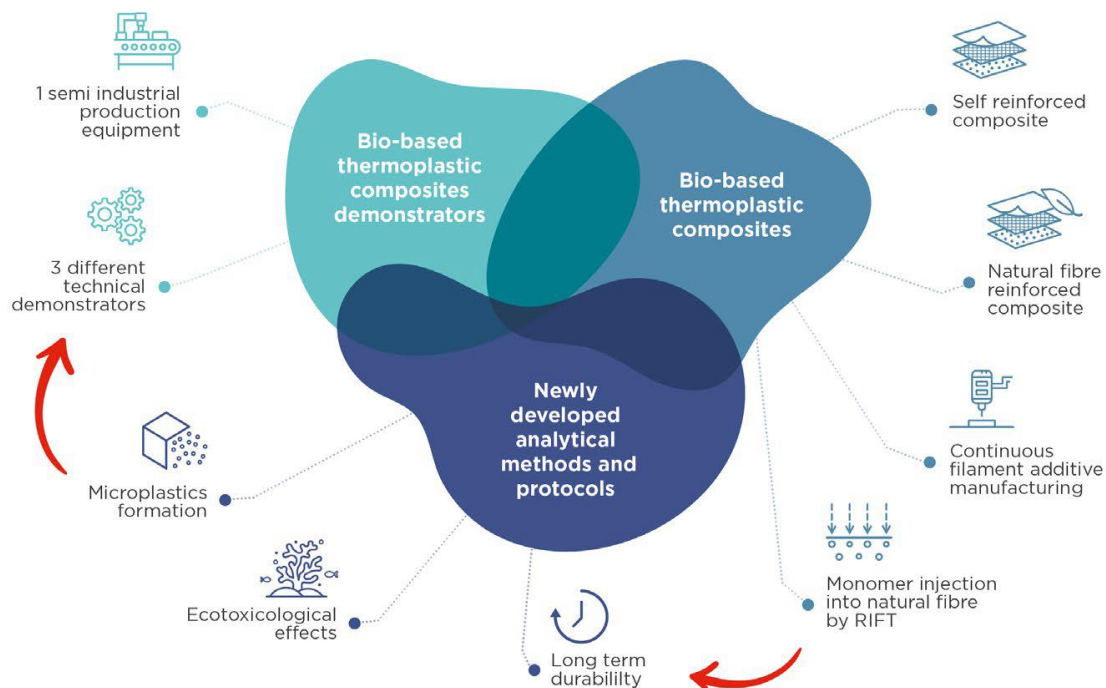


**Reduce the
environmental impact**
of composite maritime
industry components



Evaluate durability
and long-term ecological
impact from microplastics

DEVELOPMENT AND DEMONSTRATORS OF DURABLE BIOBASED COMPOSITES FOR THE MARINE ENVIRONMENT



InterReg SeaBioComp project

**natural fibres in
bio-based thermoplastic**

**Sign up for the Interest Group
to be kept informed of
results, events, activities, etc.**

[http://www.seabiocomp.eu/
interest_group/](http://www.seabiocomp.eu/interest_group/)



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Large thermoset composite marine structures

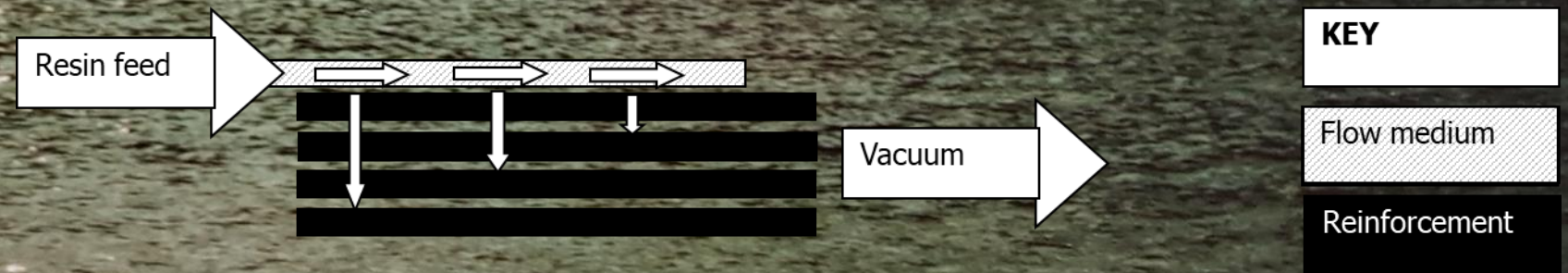
- vessels up to ~75 m overall length
 - Visby stealth corvette, M5 (was Mirabella 5) yacht
- offshore wind turbine blades to 114 m
 - Siemens Gamesa SG 2.1-114



Images from <http://www.mirabellayachts.com/mirabella5/>
<http://www.kockums.se/News/photostock/photosurface.html>
<https://www.siemensgamesa.com/en-int/products-and-services/onshore/wind-turbine-sg-2-1-114>

Resin infusion under flexible tooling with a flow medium (RIFT II)

- mould tool and membrane counterface
- long-range flow using a surface flow medium
- ideal viscosities from 200-1000 mPa.s



Monomer infusion under flexible tooling: (MIFT) = *in situ* polymerisation process

- thermoplastic melt viscosity too high
- monomers are potentially usable
- make polymer during composite manufacture

Monomer selection

Essential characteristics

Liquid monomers

YES

Viscosity suitable for infusion
(10-1000 mPa.s)

YES

Process temperature < 200°C:
no damage to natural fibre

YES

T_g > use temperature:
for structural applications

YES

Low water uptake:
avoid matrix plasticisation

YES

Desirable characteristics

Bio-based monomer

YES

Long process open time
for large structures

YES

Sensible cost/kg

YES

Low embodied energy and
environmental burdens

YES

Recyclability

YES

Icons from <https://icons8.com/>

Sustainable infused marine composites

Potential systems

- cyclic butylene terephthalate (CBT) oligomers ✗ process temperature
- BPA polycarbonate ✗ process temperature and high viscosity
- lactam to polyamide ✗ wet Tg close to use temperature
- lactide to PLA ✓ meets outline criteria
- MMA to PMMA ✓ meets outline criteria

monomer selection paper under review



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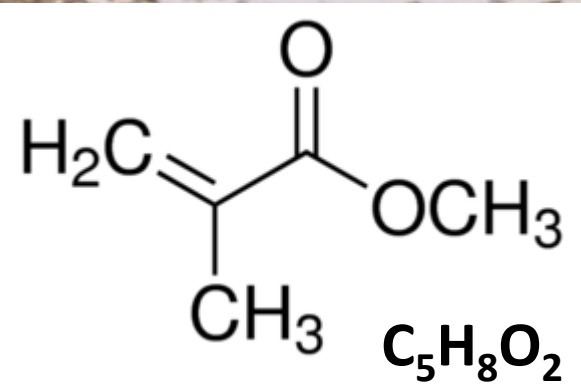


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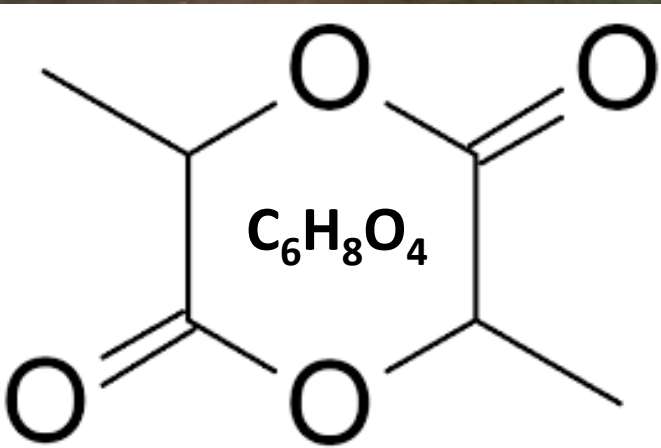
Methyl methacrylate

- addition polymerisation: no co-products
- “drop-in” substitute for resin processing
- bio-based monomer not yet commercially available
- material recovery low in end-of-life hierarchy



Lactide

- ring-opening polymerisation: no co-products
- high temperature (typically 120-180°C) processing
- bio-based monomer by default
- melt reprocessing high in end-of-life hierarchy



D 1.4.2	3D mould tool development	Mould	1	28/02/2021	31/05/2021	U Ply	Creation of a 3D mould tool with sensible temperature uniformity.
D 1.4.3	Report about the optimisation of tool design and RIFT process	Report	1	30/06/2021	30/09/2021	U Ply	Report on tooling and process parameters for components fabricated by resin infusion under flexible tooling with a flow medium using in-situ polymerisation of a monomer to produce a thermoplastic matrix composite.

Demonstrator component

- demonstrator component to be decided
- 3D mould tool with sensible temperature uniformity
 - completion deadline 31 May 2021
- optimised tool design and process for MIFT composite component
 - completion deadline 30 September 2021

Open to suggestions:
1 m square by 500 mm high?

Summary

in situ polymerisation
during MIFT for large marine structures

- methyl methacrylate
 - “drop in” option/ambient temperature
 - bio-based not yet commercially available
 - lower in the recycling hierarchy
- lactide
 - high-temperature process
 - bio-based by default
 - melt reprocessible



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